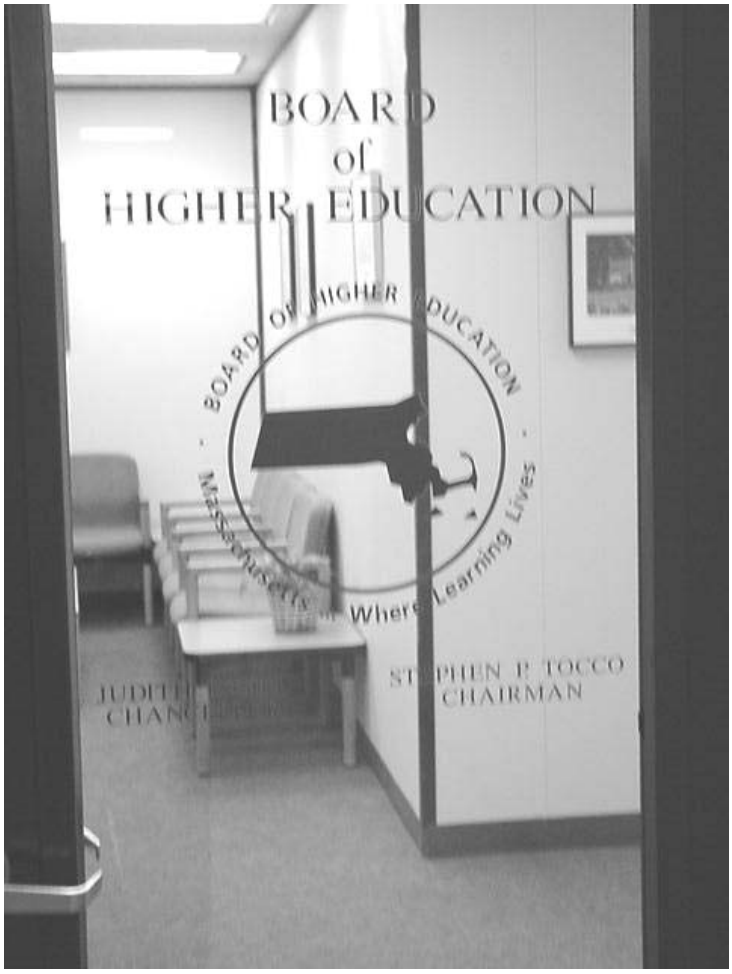
INDOOR AIR QUALITY ASSESSMENT

Board of Higher Education
McCormack Building
14th Floor
Room 1401
Boston, MA



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

Based on a request from Neil Kilpeck of the Bureau of State Buildings (BSB), an indoor air quality assessment was done in the Board of Higher Education (BHE), Room 1401 on the 14th floor of the McCormack Building, One Ashburton Place, Boston, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Occupant symptoms believed to be attributed to poor indoor air quality prompted the request.

On May 30, 2002 a visit was made to this building by Cory Holmes, an Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ), Program, BEHA. The BHE is located in a twenty-one story building on the eastern half of the 14th floor. The BHE office consists of private, single occupancy offices, work areas divided by floor dividers, and a conference room. The BHE has reportedly occupied space in the McCormack Building for 15-20 years. The building does not have openable windows.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The BHE office has an employee population of approximately 20-30 individuals. Tests were taken under normal operating conditions and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air [ppm] in all areas sampled. These carbon dioxide levels are indicative of an adequate fresh air supply in the building. Ventilation is provided by a heating, ventilation and air-conditioning (HVAC) system located in a rooftop mechanical room. Air is drawn in through a fresh air intake by a large air handling unit (AHU) (see Picture 1), which passes through two banks of high efficiency (95%) air filters (see Pictures 2 & 3) and is then distributed to occupied areas by ceiling-mounted air diffusers. Fan coil units (FCUs) located at the base of windows provide heat or cooling as needed for each room. Exhaust ventilation is provided by ducted, ceiling-mounted, return vents. Exhaust vents are also located on the exterior wall of the mechanical rooms on each floor.

In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last servicing and balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week (OSHA, 1997) based on a time-weighted average.

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I of this assessment.

Temperature readings ranged from 71° to 75° F, which were within the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° to 78° F in order to provide for the comfort of building occupants. Although the temperatures measured on the day of the assessment were within BEHA comfort guidelines, occupants expressed a number of complaints of uneven heating and cooling (see Tables). In addition a large number of portable fans were observed throughout the space, particularly in the administrative affairs section, indicating occupant dissatisfaction with air circulation. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the BHE measured during the assessment was within the BEHA recommended comfort range in all areas surveyed. Relative humidity measurements ranged from 49 to 58 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water-stained ceiling tiles, which are evidence of historic plumbing leaks or dripping condensation from metal fixtures above ceiling tiles. Water-damaged ceiling tiles can provide sources of microbial growth and should be replaced after a water leak is repaired.

Several areas had water coolers installed over carpeting (see Picture 4). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur.

Several areas had a number of plants. Plant soil and drip pans can serve as sources of mold growth. In some cases, potting soil was observed on flat surfaces and plants were on top of FCUs. Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. Several areas contained photocopiers. Photocopiers can produce volatile organic compounds (VOCs) and ozone, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992).

Periodic rodent sightings were also reported to BEHA staff. Pest traps and rodent droppings were noted in several offices and common areas (see Pictures 5 & 6). Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce symptoms readily in sensitive individuals. A three-step approach is necessary to eliminate rodent infestation:

1. removal of the rodents;

2. cleaning of waste products from the interior of the building; and
3. reduction/elimination of pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, H.A., 1995). A combination of cleaning, with an increase in ventilation and filtration should serve to reduce rodent associated allergens once the infestation is eliminated.

Several areas contain dry erase boards and markers. Accumulated dry erase board particulate was noted in a few areas (see Picture 7). Several rooms also had damaged and/or dislodged ceiling tiles. Missing/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors. Dry erase board particulate can be easily aerosolized and serve as eye and respiratory irritants. In addition, materials such as dry erase markers and dry erase board cleaners may contain VOCs (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

A number of occupants reported complaints of eye irritation. There are a number of inter-related issues that can contribute to this complaint. The most likely cause of eye irritation is the accumulation of dust on flat surfaces throughout the space. Dust can be irritating to the eyes, nose and respiratory tract. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Accumulated dust and/other particulates were noted on supply/return vents, within FCUs and on the blades of portable fans. When fans or FCUs are activated these

materials can become aerosolized. Another factor influencing the amount of airborne dust particles is the continuing operation of the HVAC system. The HVAC system provides a constant source of airflow throughout the space, which can reaerosolize settled dust on flat surfaces throughout the space.

BEHA staff observed a number of VOC-containing cleaning materials that BHE personnel use to clean personal work areas. A strong odor of lemon furniture polish was noted in the conference room. The material shown in Pictures 8 & 9 contains several VOCs (e.g., isopropyl alcohol and monoethanolamine) that can be irritating to the eyes, nose and throat (3M, 2000). These materials, in combination with those conditions discussed earlier (e.g., potting soil/plants on FCUs, accumulated items/dust, rodent allergens) if considered individually present conditions that could degrade indoor air quality. When combined, these conditions can serve to exacerbate conditions leading to eye irritations and other indoor air quality comfort complaints.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following short-term recommendations are made:

1. Continue to work with the BSB engineering department to address areas of on-going ventilation/comfort complaints. Consider reconfiguring work areas and/or make adjustments to the building's ventilation system to improve temperature control and airflow.
2. Consider having the systems balanced every five years by a ventilation-engineering firm (SMACNA, 1994).

3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
4. Repair any existing water leaks and replace any water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
5. Place rubber/plastic matting beneath water cooler to prevent water damage to carpeting.
6. Replace damaged/dislodged ceiling tiles to prevent the egress of dirt, dust and particulate matter into occupied areas.
7. Relocate or consider reducing the amount of stored materials to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
8. Clean dry erase board trays regularly to avoid the build-up of particulates.
9. Continue to change HVAC filters on current schedule or more frequently if needed. Vacuum interior of FCU prior to activation to prevent the aerosolization of dirt, dust and particulates.
10. Clean portable fan blades, supply and return vents periodically of accumulated dust.

11. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/ building management in a manner to allow for optimal and timely remediation of the problem.

12. Refrain from using strong scented and/or VOC-containing materials.

13. Use integrated pest management (IPM) to remove pests from the building. A copy of the IPM recommendations is included with this report as Appendix II (MDFA, 1996). Activities that can be used to eliminate pest infestation may include the following activities.

    i) Consult a licensed pesticide applicator on the most appropriate method to end infestation.

    ii) Reduction/elimination of pathways/food sources that are attracting pests.

    iii) Reduce harborages (plants/cardboard boxes) where pests may reside.

References

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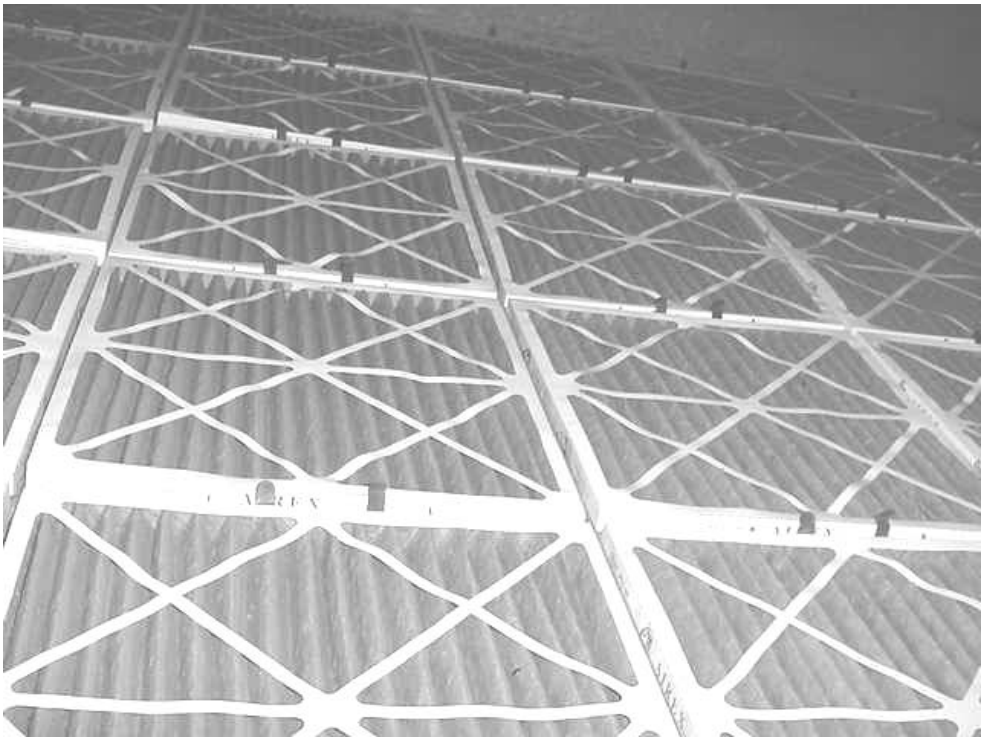
US EPA. 1992. Indoor Biological Pollutants. US Environmental Protection Agency, Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Research Triangle Park, NC. ECAO-R-0315. January 1992.

3M 2000. Material Safety Data Sheet (MSDS Document No: 10-0157-7). 3M Brand Desk and Office Cleaner 573. Minnesota Mining and Manufacturing Company. St. Paul, Minnesota.

Picture 1

AHU for 14th Floor in Rooftop Mechanical Room

Picture 2

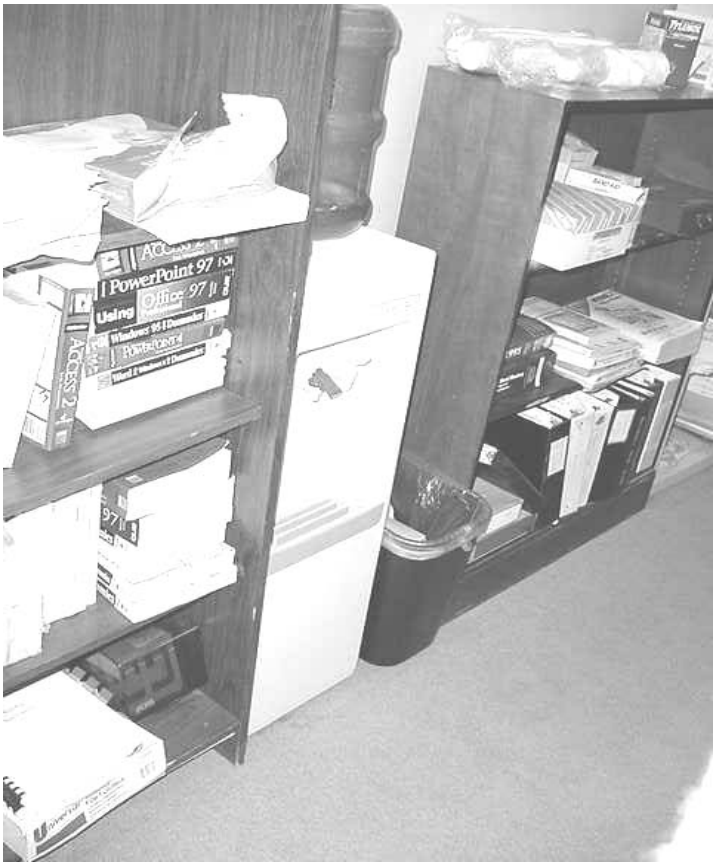


First of Two Filter Banks for HVAC System

Picture 3

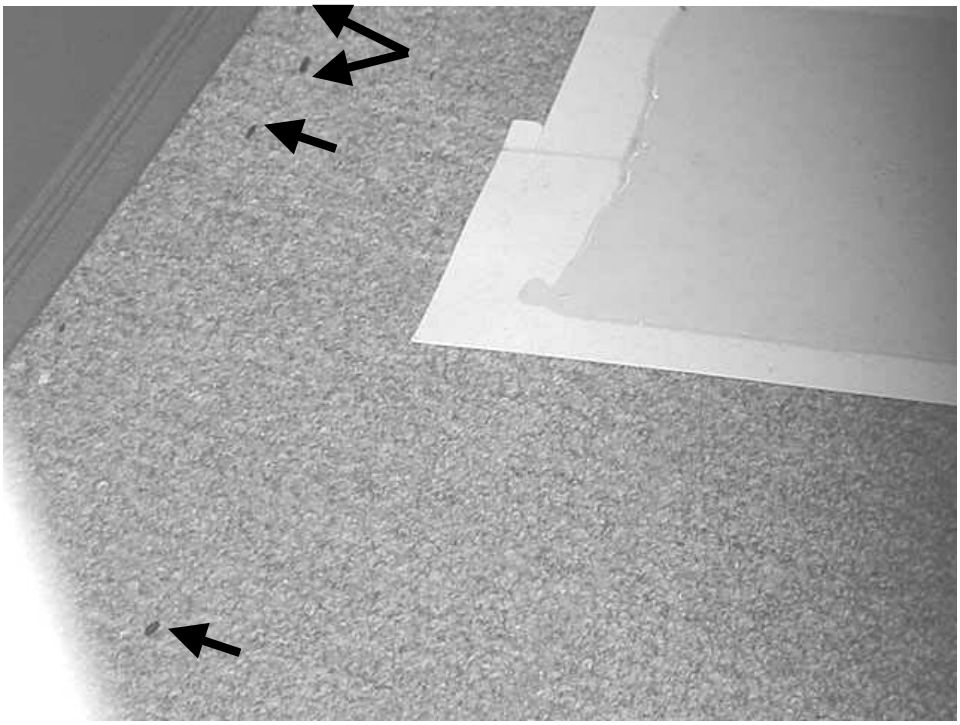
Second Filter Bank for HVAC System

Picture 4



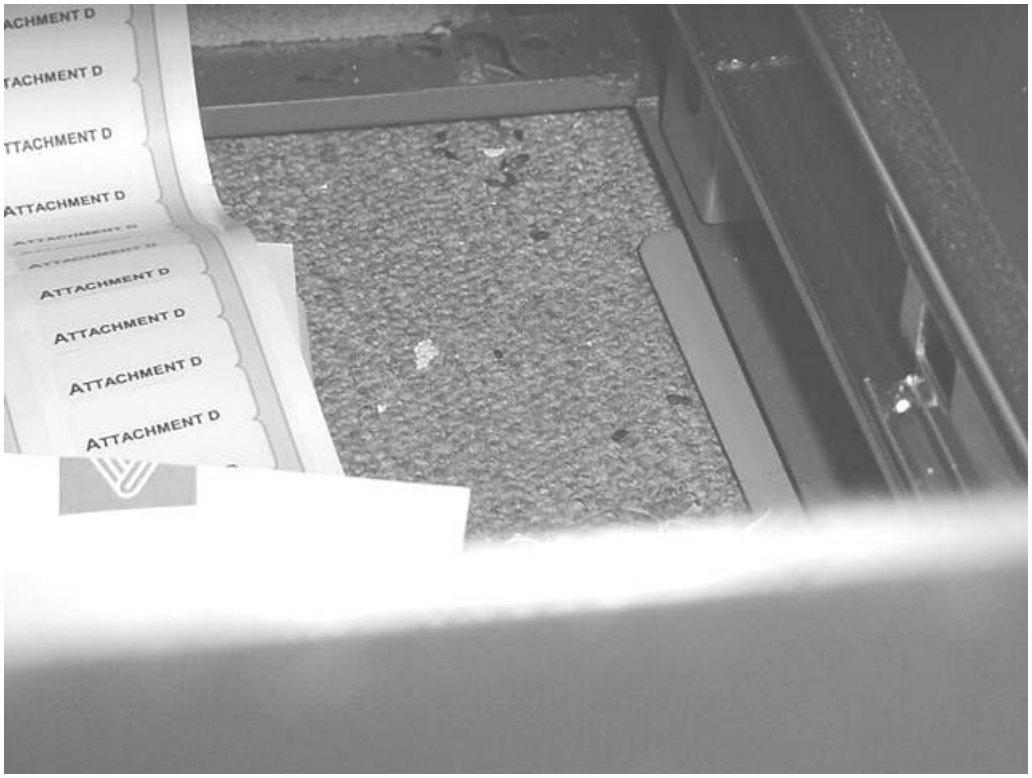
Water Cooler on Carpeting

Picture 5



Pest Trap and Rodent Droppings

Picture 6



Rodent Droppings beneath Drawer of File Cabinet in Employee's Cubicle Outside of (Weening) Office

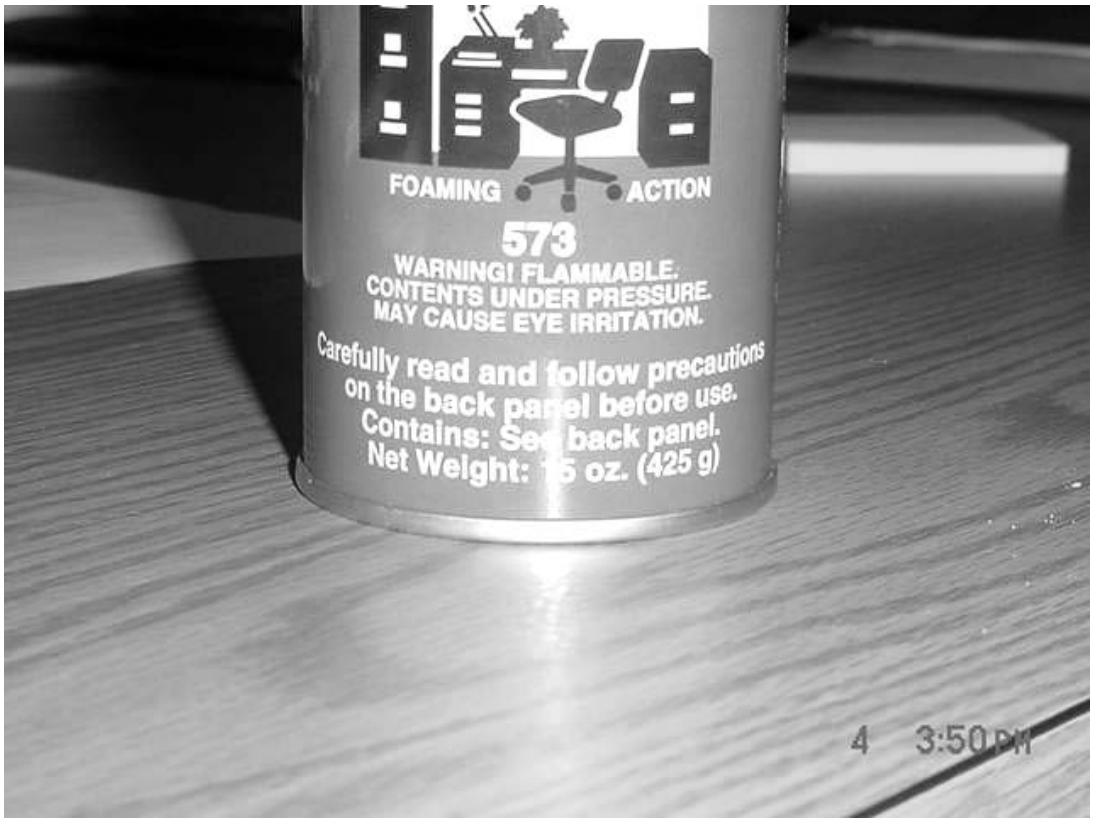
Picture 7

Dry Erase Board Markers and Particulates

Picture 8

VOC-Containing Cleaning Material

Picture 9



Close-up of Warning Label on Cleaning Material in Previous Picture

TABLE 1

Indoor Air Test Results – McCormick Building, Boston, MA – May 30, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Outside (Background)	439	0-4	75	57					Clear, sunny, SW wind 10-15 mph, ~10:00 am
Conference Room	487	1	73	52	1	No	Yes	Yes	Dust accumulation on fan, reported heat issues in summer
McCauley	562	0	72	55		No	Yes	Yes	Fan, plants, fan coil unit on, heat issues (summer), door open
Smith	564	0	72	54	1	No	Yes	Yes	Pest traps on floor
Conboy	533	1	72	55	0	No	Yes	Yes	2 large computer monitors, laser jet printer
Gill	563	1	71	57	2	No	Yes	Yes	Plants, temperature control issues/extremes, 1 stained CT
Egan	594	1	71	58	2	No	Yes	Yes	Fan-on, dirt/dust accumulation on fan coil unit return vent, reported reoccurring illness since September
Macuga	573	1	73	56	2	No	Yes	Yes	
Plummer	547	1	78	56	0	No	Yes	Yes	Fan-dusty

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – McCormick Building, Boston, MA – May 30, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Kelly	483	1	73	55	0	No	Yes	Yes	Fan on, plant
Williams	508	1	73	55	1	No	Yes	Yes	Plants-1 on fan coil unit-soil on top of unit, reported fatigue/allergies
E. Smith					1	No	Yes	Yes	
Jaffe	496	1	73	55	0	No	Yes	Yes	Dry erase board, fan
Outside E. Smith Office	511		73	55	1	No	Yes	Yes	
Wood/Bejar	544		73	54	1	No	Yes	Yes	Dust accumulation around vent, dry erase board, door open
Weening	517		73	55	2	No	Yes	Yes	Plant
Cubicle Outside Weening Office	513		73	55	0	No	Yes	Yes	Reported sinus infections, headaches, ear problems, mice droppings beneath drawer and corner of cube

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CT = ceiling tiles

Comfort Guidelines

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results – McCormick Building, Boston, MA – May 30, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Tsaffaras	508		74	53	0	No	Yes	Yes	Dry erase board, dust accumulation on fans
Cubicle Outside Tsaffaras Office	517		74	54	1	No	Yes	Yes	
Hagen (cubicle)	518	2	74	52	0	No	Yes	Yes	
LaPorte	519	1	74	53	0	No	Yes	Yes	Items on/in front of fan coil units
Shannon	510	1	74	51	0	No	Yes	Yes	Dim-possible lighting issues
Administrative Affairs		1							Numerous fans, water fountain on carpet
Willis	510	1	74	54	0	No	Yes	Yes	Plants
Wong	463	1	74	54	0	No	Yes	Yes	Plant
Lurigan	472	1	74	55	0	No	Yes	Yes	Spray cleaner, eye irritant, plants, fan on
Lee	520	1	75	53	1	No	Yes	Yes	Plants on fan coil unit

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Comfort Guidelines

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – McCormick Building, Boston, MA – May 30, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Sullivan	542	1	75	52	0	No	Yes	Yes	
Hacker	536	2	75	52	1	No	Yes	Yes	Dry erase board-particulate in tray, stuffy-poor air flow, temperature issues-heat/comfort
Copy Room	542	2	75	49	0	No	Yes	Yes	Photocopier-heavy use, fax
Conference Room									Strong odor of lemon cleaner/furniture polish

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%